Comparative Analysis of Utility Consumption and Costs of Near-ZEHs and Comparison Homes in California[1]

Timothy C. Coburn, Abilene Christian University
Barbara C. Farhar, National Renewable Energy Laboratory
Lew Pratsch, U.S. Department of Energy

ABSTRACT

A SheaHomes development at Scripps Highlands in San Diego, California, began in June 2001 to offer near-zero-energy homes (ZEHs)—highly efficient homes with solar water heating, and in some, solar electricity as standard features—the first such offering in the United States. By November 2003, all 306 homes were sold. The National Renewable Energy Laboratory (NREL) has followed this development, including the builder experience; home resale values; homeowner characteristics, decisions, and experiences; and the consumption and cost of electricity and gas in the near-ZEHs and in adjacent comparison homes. Three papers on these topics (except the utility analysis) have been presented at the American Council for an Energy-Efficient Economy 2002 and 2004 Summer Studies (Coburn, Farhar & Murphy 2004; Farhar, Coburn & Collins 2002; and Farhar, Coburn & Murphy 2004).

We analyzed the utility data obtained for the SheaHomes and comparison homes to determine whether statistically significant differences in energy consumption and energy costs can be attributed to the energy efficiency and solar features of the high-performance homes by comparing them with similar conventional homes in the identical climate during the same 12-month period (July 1, 2003 through June 30, 2004).

This paper presents the results of an analysis of differences in electricity and gas consumption and costs in the high-performance homes in the context of recently published analyses on near-ZEHs in other parts of California. The results suggest an emergent pattern of data that support claims of substantial savings in electricity costs in near-ZEHs.[2]

Background of the SheaHomes Development

A near-zero-energy home (ZEH) combines state-of-the-art, energy-efficient construction and appliances with commercially available renewable energy systems to reward its owner with net zero energy consumption. A ZEH, like any home, is connected to the utility grid, but overall it produces as much energy as it consumes. With net metering, the home's electric meter runs backward when the home produces more power than it uses. With its reduced energy needs and solar energy systems, a ZEH can, over the course of a year, produce as much energy as it uses. ZEHs are thought to have a number of advantages, including improved comfort, protection against electricity price spikes, and environmental sustainability.

---

[1]This work has been authored by an employee or employees of the Midwest Research Institute under Contract No. DE-AC36-99GO10337 with the U.S. Department of Energy. The United States Government retains and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for United States Government purposes.

[2] The full analysis of these data is presented in Farhar & Coburn 2006.

The SheaHomes Scripps Highlands development near San Diego, California, was the first offering of its kind in the United States. According to advertisements at the time, the homes would enable homebuyers to reduce their utility bills 30%−50% annually over conventional homes. SheaHomes began closing on these homes in April 2001; by November 2003, all 306 homes were sold. The homes ranged in price from $400,000 to $840,000. The Scripps Highlands area, situated on a mesa north of San Diego and close to Interstate 15, is considered highly desirable. The area has views of rolling hills, valleys, and the Pacific Ocean 15 miles to the west. New homebuyers in this area were exempt from certain property taxes that new homebuyers elsewhere in the San Diego area had to pay.

Methods

This study is an empirical and statistical investigation of the differences between buyers of new high-performance homes and buyers of new conventional homes (that is, homes built to Title 24 building standards in California). It includes contextual, qualitative, and quantitative data, but it does not include engineering data or engineering analyses. It encompasses two distinct phases of work—a qualitative phase and a quantitative phase—during which different types and sources of data were investigated.

The homes covered by the study were constructed and offered for sale by two different builders. The principal target population consisted of 306 homebuyers in SheaHomes' San Angelo and Tiempo developments at Scripps Highlands in northern San Diego County. All homes in these developments are highly energy efficient, and most are high-performance homes with solar features. The comparison group consisted of 103 buyers of conventional homes that were constructed by a different builder in an adjacent community.

The comparison community was chosen because of its proximity to the San Angelo and Tiempo developments and the similarity of price range and housing type. The weather and climate of the two communities are identical. Although built to the California Title 24 Standard in effect in 2001, the homes in the comparison community have no special energy efficiency and solar features.

The first phase of the study included meetings with the project advisory committee, as well as numerous interviews with staff members and representatives of SheaHomes, organizations, and companies that partnered with SheaHomes, and the builder of the comparison homes. Other interested parties in the ZEH community were also interviewed. Field researchers visited homes in the SheaHomes community that were already occupied. They spent time at the SheaHomes sales centers to observe how the sales staff interacted with the potential homebuyers, especially relative to the homes' energy efficiency and solar features. Researchers visited the comparison home sales office and show homes, posing as interested home shoppers to learn whether the sales staff said anything about energy efficiency in the comparison homes (they didn't). Although the SheaHomes sales staff was aware of the researchers' roles, the comparison builder's staff was not. Field researchers visited five developments before they selected one to serve as the comparison community.

These meetings, observations, and interviews facilitated the collection of contextual data and information necessary to focus future data collection efforts. Also during this phase, information about "lost lookers" was obtained through a telephone survey of visitors to the SheaHomes' Scripps Highlands Sales Center. Results of these interviews are reported by Collins (2003). Finally, qualitative interviews of early homebuyers in SheaHomes' Scripps Highlands

development were conducted. Results of these interviews are reported in Farhar, Coburn & Collins (2002). Along with the contextual data, the findings from the interviews of early homebuyers formed a foundation for the study's second phase.

The second phase consisted of a comprehensive mail survey, along with a detailed statistical analysis of the survey responses. This survey encompassed all homebuyers in SheaHomes' San Angelo, and Tiempo developments, as well as all homebuyers in the nearby development of conventional homes. The questionnaires used in the survey were based, in part, on the results of the qualitative interviews of early homebuyers in the SheaHomes communities. Preliminary findings from the quantitative phase of the study are reported in Coburn, Farhar & Murphy (2004). This phase also included collection and analysis of utility billing and consumption data from respondents in SheaHomes and comparison homes. To obtain actual utility consumption and cost data for study homes, respondents were asked to sign a utility release form that permitted San Diego Gas & Electric (SDG&E) to provide their utility data to NREL. Of the 231 questionnaire respondents, 132 (57%) returned the utility release forms with valid signatures. NREL provided the utility release forms to SDG&E, who then provided NREL with the monthly electricity and gas consumption and cost data in Excel format for each household that had given permission. The utility data cover the period from the time the house was occupied until June 30, 2004.

A typical monthly utility bill for one household consists of days of service in the billing month, amount of electricity used (in kWh), cost and tax for electricity used, and miscellaneous costs associated with electricity used, plus amount of gas used (in therms) and cost and tax for gas use. Other information associated with the dates of service is also included. Because respondents moved into their homes and initiated service on different dates, the number of months of utility data for each household varies. The number of days per monthly billing cycle varies slightly; however, meters are read on the same day each month at all houses in the study neighborhoods.

For consistency, all records in the data set were omitted for which the number of days per billing cycle was fewer than 28. The decision was also made to restrict the data set of homes to those that had experienced at least 1 full year of utility service and to use the last 12 months (July 2003 through June 2004) of the study period to include as many homes as possible. As a result, the utility data set was reduced to records from 122 homes (40 homes with PV systems, 51 high-performance homes with solar water preheating systems but no PV systems, and 31 comparison homes). The data revealed a high degree of variation in electricity and gas consumption among all the homes. Side-by-side box plots of 12-month total electricity consumption were constructed that depict the distribution of values for the three categories of homes. The box plots indicate the presence of statistical outliers. Ultimately, the utility records of 10 more homes were eliminated to ensure data consistency in the analysis. As a result of this additional data screening, the utility data set was reduced to records from 109 homes (37 PV homes; 44 high-performance homes with solar water heating systems but no PV systems; and 28 comparison homes).

Percentages of Energy Cost Savings at the SheaHomes Scripps Highlands Relative to Comparison Homes

Tables 1−5 present data from the current study on the percentages of savings on electricity and gas bills for various categories of homes. These homes have various combinations of energy-intensive equipment and amenities that reflect real-world conditions (Farhar & Coburn

2006). In all cases, the SheaHomes high-performance homeowners enjoyed lower electricity and gas bills, on average, than did the comparison homeowners for the 12-month period from July 1, 2003 through June 30, 2004.

As Table 1 shows, the mean annual electricity cost was 13% lower for the SheaHomes without PV systems than for the comparison homes when taxes and other charges are included, and the mean monthly electricity cost with all charges was 14% lower. The gas costs were even more advantageous to the SheaHomes owners, fully 17% lower than the comparison community homes' gas costs, on average. These savings are attributable to the energy efficiency features of the SheaHomes without PV systems that save electricity and gas that would otherwise have been used for space conditioning. The savings in gas costs near statistical significance (p=.059).

Table 1. Percentage Differences in Electricity and Gas Costs of SEE Homes and Comparison Homes

Electricity Costs	SEE Homes*** (*n* = 44)	Comparison Homes (*n* = 28)	Percentage Difference
Mean annual electricity cost including taxes and miscellaneous charges (t-test n.s.; p=.214)	$1,360.43	$1,562.98	13%
Mean annual electricity cost excluding taxes and miscellaneous charges (t-test n.s.; p=.183)	$1,236.37	$1,434.87	14%
Mean monthly* electricity cost including taxes and miscellaneous charges (t-test n.s.; p=.217)	$ 103.21	$ 119.67	14%
Mean monthly* electricity cost excluding taxes and miscellaneous charges (t-test n.s.; p=.186)	$ 113.56	$ 130.34	13%
Gas Costs			
Mean annual gas cost including taxes and miscellaneous charges (t= –1.940; p=.059**)	$ 427.17	$ 516.61	17%
Mean annual gas cost excluding taxes and miscellaneous charges (t= –1.937; p=.059**)	$ 400.95	$ 485.05	17%
Mean monthly* gas cost including taxes and miscellaneous charges (t= –1.938; p=.059**)	$ 35.76	$ 43.22	17%
Mean monthly* gas cost excluding taxes and miscellaneous charges (t= –1.936; p=.059**)	$ 33.56	$40.58	17%

*12-month average

**These results near statistical significance

*** SEE homes are SheaHomes high-performance homes with solar water preheating systems, but no solar PV systems

Table 2 compares data on the same variables for SheaHomes with PV systems[3] and the comparison homes. In this instance, the mean electricity savings are higher, with the SheaHomes PV owners saving, on average, 35% on electricity costs compared to the comparison homeowners. Interestingly, the gas savings of the PV homes are even higher than for the SheaHomes in general, averaging 27%, or 10 points higher than for SheaHomes as a whole. These savings may be attributed to the SheaHomes' energy efficiency and solar PV features, as well as additional factors. The cost savings could result simply from greater consciousness of

[3]Ignoring size of PV system.

energy consumption on the part of solar PV residents, the floor plans or orientations of solar PV homes, or other factors.

Table 3 compares data on these variables for SheaHomes with PV systems[4] to those without them. The PV homeowners enjoy 25% lower electricity bills, on average, than do the non-PV homes. They also enjoy a 17% cost saving on their gas bills, on average. Table 4 compares data on the same set of variables for SheaHomes with 1.2-kW PV systems and SheaHomes with 2.4-kW PV systems. The percentage differences in electricity cost are the highest of all the comparisons. All these differences are statistically significant. SheaHomes owners of 2.4-kW solar PV systems save an average of 46% on their annual electricity costs compared with SheaHomes owners of 1.2-kW solar PV systems. Clearly, this finding is a function of PV system size. Further, the owners of the larger PV systems average an incremental saving of 2%, on average, on their mean monthly gas bills.

Table 2. Percentage Differences in Electricity and Gas Costs of SheaHomes with PV Systems and Comparison Homes

Electricity Costs	SheaHomes with PV Systems (*n* = 37)	Comparison Homes (*n* =2 8)	Percentage Difference
Mean annual electricity cost including taxes and miscellaneous charges (t= –3.196; p=.002)	$1,015.38	$1,562.98	35%
Mean annual electricity cost excluding taxes and miscellaneous charges (t= –3.422; p=.001)	$ 922.32	$1,434.87	36%
Mean monthly* electricity cost including taxes and miscellaneous charges (t= –3.190; p=.003)	$ 84.77	$ 130.34	35%
Mean monthly* electricity cost excluding taxes and miscellaneous charges (t= -3.415; p=.001)	$ 77.00	$ 119.67	36%
Gas Costs			
Mean annual gas cost including taxes and miscellaneous charges (t= –3.105; p=.003)	$ 375.72	$ 516.61	27%
Mean annual gas cost excluding taxes and miscellaneous charges (t= –3.102; p=.003)	$ 352.52	$ 485.05	27%
Mean monthly* gas cost including taxes and miscellaneous charges (t= –3.098; p=.003)	$ 31.48	$ 43.02	27%
Mean monthly* gas cost excluding taxes and miscellaneous charges (t= –3.095; p=.003)	$ 29.53	$ 40.58	27%

*12-month average

New Large-Production Home Builder Solar Developments in California

Since this study began, large-production builders other than SheaHomes have initiated new solar home projects in California. According to the 2006 Mortgage Industry National Home Energy Rating Standards (HERS), a ZEH is a home that saves 100% of its energy consumption compared to a HERS reference home of the same size (RESNET 2006). The newly adopted "HERS Index" uses a score of "0" for a net zero energy home while a score of "100" equates to the HERS reference home. None of the PV homes built in California since the SheaHomes Scripps Highlands development meet the true ZEH standard; however, at least 13 projects in California feature homes with solar electric (solar PV) systems. Table 5 summarizes these

[4]Ignoring size of PV system.

developments. At least six large-production builder companies offer these solar homes: Clarum Homes, K. Hovnanian, Morrison Homes, Pardee, Premier Homes, SheaHomes, and US Homes. More than 1,800 solar homes have been built or are being planned in California communities as of this writing.

Clearly, at least a small percentage of large-production builders in California has recognized a market for new solar homes. These "early adopter" builders are climbing the necessary learning curve to build and offer these innovative homes. The homes provide the builders with market differentiation, free advertising through media interest, fast sales, a market edge because of substantially reduced utility bills, and community goodwill (Hammon 2005).

Table 3. Percentage Differences in Electricity and Gas Costs of SheaHomes with PV Systems and SEE Homes

Electricity Costs	SheaHomes with PV Systems (*n* = 37)	SEE Homes (*n* = 44)	Percentage Difference
Mean annual electricity cost including taxes and miscellaneous charges (t= –2.671; p=.009)	$1,015.38	$1,360.43	25%
Mean annual electricity cost excluding taxes and miscellaneous charges (t= –2.653; p=.010)	$ 922.32	$1,236.37	25%
Mean monthly* electricity cost including taxes and miscellaneous charges (t= –2.669; p=.009)	$ 84.77	$ 113.56	25%
Mean monthly* electricity cost excluding taxes and miscellaneous charges (t= –2.651; p=.010)	$ 77.00	$ 103.21	25%
Gas Costs			
Mean annual gas cost including taxes and miscellaneous charges (t-test n.s.)	$ 375.72	$ 427.17	17%
Mean annual gas cost excluding taxes and miscellaneous charges (t-test n.s.)	$ 352.52	$ 400.95	17%
Mean monthly* gas cost including taxes and miscellaneous charges (t-test n.s.)	$ 31.48	$ 35.76	17%
Mean monthly* gas cost excluding taxes and miscellaneous charges (t-test n.s.)	$ 29.53	$ 33.56	17%

*12-month average

The market experience for these homes appears to be positive. For example, Clarum Homes reportedly sold 60% of the 257 solar homes at Vista Montana before its grand opening, and sold out completely one year ahead of schedule (Hering 2005). In fact, the builder has decided to build only ZEHs that cut energy bills in half in the future (Hammon 2005).

Table 5 shows a relatively modest number of solar homes compared to the estimated 150,000 new housing starts in California during 2005 (Hering 2005). Still, some of the solar home developments are quite large. For example, Lennar Communities is involved in the Bickford Ranch development in Placer County and is developing a 1,600-home community with 1.2-kW systems at Hunters Point Naval Shipyard in San Francisco.

New technology is helping to spur builder interest in solar homes. Roof-integrated PV systems—such as PV tiles or shingles—blend seamlessly into roofs. These building-integrated PV systems are preferred by homebuilders for aesthetic reasons.

Table 4. Percentage Differences in Electricity and Gas Costs of SheaHomes with 1.2-kW PV Systems and SheaHomes with 2.4-kW Systems

Electricity Costs	SheaHomes with 1.2-kW PV Systems (n = 31)	SheaHomes with 2.4-kW PV Systems (n = 6)	Percentage Difference
Mean annual electricity cost including taxes and miscellaneous charges (t=2.140; p=.039)	$1,097.42	$ 591.48	46%
Mean annual electricity cost excluding taxes and miscellaneous charges (t=2.169; p=.037)	$ 998.42	$ 529.13	47%
Mean monthly* electricity cost including taxes and miscellaneous charges (t=2.137; p=.040)	$ 91.60	$ 49.25	46%
Mean monthly* electricity cost excluding taxes and miscellaneous charges (t=2.166; p=.037	$ 83.34	$ 44.24	47%
Gas Costs			
Mean annual gas cost including taxes and miscellaneous charges (t-test n.s.)	$ 376.98	$ 369.21	2%
Mean annual gas cost excluding taxes and miscellaneous charges (t-test n.s.)	$ 353.73	$ 346.30	2%
Mean monthly* gas cost including taxes and miscellaneous charges (t-test n.s.)	$ 31.59	$ 30.91	2%
Mean monthly* gas cost excluding taxes and miscellaneous charges (t-test n.s.)	$ 29.64	$ 28.99	2%

*12-month average

Table 5. Solar Home Developments in California, 2005

Name of Development	Builder and Location	Price Range	Number of Homes; PV System Sizes
Premier Gardens Rancho Cordova	Premier Homes Sacramento	$150,000 to $270,000	99 homes 2.4-kW PV systems
Terramore at Ladera Ranch	SheaHomes Orange County	$900,000 to $1 million starting price	87 homes 2.4-kW PV systems
Vista Santa Barbara	Pardee Homes San Diego	–**	–
Evergreen at Ladera Ranch	Pardee Homes Orange County	–**	77 homes; 29% with 2.4-kW PV systems
Ladera Ranch San Diego	Other builders	–**	122 homes with 1.2 kW and 2.4-kW PV systems***
Mosiac Ladera Ranch	K. Hovnanian Orange County	$1 million	89 homes
Vista Montana	Clarum Homes Watsonville	$340,000 to $380,000	257 homes 1.2- to 2.4-kW PV systems
Shorebreeze I, II, III, and IV	Clarum Homes Palo Alto	$595,000 (Phase IV)	39 homes
Hamilton Park	Clarum Homes Menlo Park	–**	47 homes
KD Development San Diego	–**	–**	100-150 homes
Premier Oaks	Premier Homes Roseville	–**	49 homes 2-kW PV systems
Bickford Ranch	US Homes Lennar Communities Placer County	–**	917 proposed homes
Lakeside Elk Grove	Morrison Homes	–**	120 homes; only 12 with 2-kW PV systems

*Other builders of solar homes mentioned by Hering (2005) are Centex Homes and Standard Pacific Homes.
**Information not available.
***Hering (2005) reports that GE Energy is supplying 350 systems to Terramore Village at Ladera Ranch in Orange County.
Sources: http://environmentcalifornia.org/ accessed 9/1/05 and unpublished case studies by Bruce Baccei, Consol, 2005

Performance of Near-ZEHs: The Premier Gardens Case

Keesee (2005) reports that Premier Gardens, which was developed by Premier Homes in Sacramento, California, is the first "all ZEH" community.[5] Keesee also claims that these homes have a package of energy efficiency measures that reduces heating and water heating energy use by more than 15% and cooling energy use by 50%, compared to California's Title-24 building energy standards.

Results reported by the Sacramento Municipal Utility District (SMUD) from an analysis of 10 months of utility data that compared the 95 Premier Gardens homes with 95 nearby SMUD Advantage Homes, which reduce the Title 24 estimated cooling budget by 30% homes (Keesee 2005) are as follows:[6]

- On average, 16% less electricity was used by the Premier Gardens Homes than by the comparison homes during the first 10 months of occupancy.[7]
- PV systems supplied more than 47% of the electricity in the Premier Gardens Homes.
- Average monthly electricity bills are 54% lower in the Premier Gardens Homes than in the comparison homes.
- Average monthly electricity bills for the Premier Gardens Homes are 50% lower than the average monthly SMUD residential bill.

A corresponding analysis of April 2005 bills conducted by Keesee (2005) showed that the average electricity bills for this one month were 78% lower than the "typical SMUD bill" and 63% lower than the comparison homes' bills. A SMUD analysis of December 2004 bills shows that the Premier Gardens' electricity bills were 42% lower than "typical residential customers" for this month (Hering 2005).

Hammon (2005) also analyzed a comparison of one month of electricity bills in September 2004 for Premier Gardens and comparison homes. He reports that 22 of the Premier Gardens "near-ZEHs" used 60%−70% less electricity than 17 neighbor homes in the Sacramento area during that month. The size of the PV systems was not reported, but other sources suggest that it was 2 kW (cf. Table 1). Data on square footage, occupancy, equipment, and other factors that affect energy consumption—and therefore bills—are not reported.

Results from the Premier Gardens development were also reported in a *Newsweek* article (Murr 2005), which claimed that their average power saving is 60%. The story describes the energy features of the community, including 2-kW solar modules on the roof, spectrally selective windows, "fluorescent bulbs" (probably referring to compact fluorescent lights), and tankless water heating. The homes are net metered. SMUD's Keesee is quoted as saying that the project "helps us lower usage at peak power times. That lets us avoid building costly plants or buying expensive power at peak usage time."

---

[5]Technically, this is not accurate because these homes cannot provide all the energy they use. Data reported in Keesee (2005).

[6]Although Keesee (2005) provided no information on the methodology used in this analysis, a paper that describes the study is being presented at the 2006 ACEEE Summer Study.

[7]The 16% difference in efficiency is absent the contribution from the PV systems (and in comparison to the SMUD Advantage homes that are specified to have 30% reduced cooling). The 54% bill reduction includes contributions from both efficiency and generation. The number of homes included in the analysis is not reported.

The article reported that the Premier Gardens' energy features add $18,000 to the purchase price of the home, and in other locations can add $25,000 or more. California subsidizes approximately 50% of the cost of the solar PV systems.

Our study did not analyze the effects on peak demand of the SheaHomes Scripps Highlands development. However, this is an important question. Relative to ZEH impacts on utility peak demand, SMUD analyses show that peak electrical demand has been reduced by as much as 13% in homes that participated in the PV Pioneer retrofit and Solar Advantage Home PV programs. SMUD estimates that, if all new homes built during 2004 had been built to ZEH standards with PV systems oriented west of south, the utility could have realized a peak load reduction up to 20 MW (Keesee 2005). SMUD plans continued analysis of the performance of the ZEH homes' electrical usage, bills, and peak demand effects to determine the impact of ZEHs on the utility's system peaks.

A Comparative Analysis

It is useful to discern if the data from our study on electricity cost savings support the Keesee (2005) and Hammon (2005) findings that compare Premier Gardens homes with neighboring comparison homes. As noted above, Keesee (2005) reports mean monthly electricity bills that are 54% lower than those of comparison homes for the first 10 months of occupancy (number of homes not reported). Also as previously noted, Keesee also reports a 63% lower electricity bill for April 2005 compared with those of comparison homes, Murr (2005) reports a 60% saving on electricity bills, and Hammon (2005) reports 60%−70% lower electricity bills for September 2004 compared with comparison homes. An analogous case that uses our study's data compares electricity bills from the homes with 2.4-kW PV systems with the electricity bills of the comparison homes. The findings should be similar because the PV system size reported for Premier Gardens is 2 kW AC, approximately equivalent to the 2.4-kW DC PV systems in the current study. Table 6 exhibits the costs and percentage differences for electricity and gas bills, as well as for combined utility bills, for the comparison homes and the SheaHomes with 2.4-kW PV systems only. The data span 12 months. As Keesee's and Hammon's studies would predict, *the savings on electricity bills for these small groups of homes average 62%−64%*, depending on which cost variable is examined.

Indeed, the combined total utility costs for the 12-month period of analysis shows that the SheaHomes with 2.4-kW PV systems save 54% on their *overall combined utility bills* for the 12-month period, on average, compared with the overall combined utility bills for the comparison homes. Thus, the claims made by researchers, engineering estimates, and analyses of actual performance of near-ZEHs are borne out by the data in this study.

Our findings are not strictly comparable to those reported from the Premier Gardens studies. For one thing, the analyses reported here measure an annual utility billing cycle rather than one month or 10 months of billing data, which were the foci of previous investigations. In addition, two different sets of homes are involved with different characteristics and located in different climates. Perhaps their only common characteristics are certain energy features. Also, the Premier Gardens solar PV systems are larger than are most of the SheaHomes' 1.2-kW DC solar PV systems.

Despite these limitations, the percentage of electricity cost savings in the current study appears significant, and is similar to the electricity cost savings reported by Keesee (2005) and Hammon (2005) for Premier Gardens, and to those reported by Murr (2005). In addition, high-

performance homes and near-ZEHs save electricity and gas costs to such an extent that homeowners can perceive the cost savings (Farhar and Coburn 2006).

Table 6. Percentage Differences in Electricity and Gas Costs of Comparison Homes and SheaHomes with 2.4-kW PV Systems

Electricity Costs	Comparison Homes (n = 28)	SheaHomes with 2.4-kW PV Systems (n = 6)	Percentage Difference
Mean annual electricity cost including taxes and miscellaneous charges	$1,562.89	$ 561.48	64%
Mean annual electricity cost excluding taxes and miscellaneous charges	$1,434.87	$ 529.13	63%
Mean monthly electricity cost including taxes and miscellaneous charges	$ 130.35	$ 49.45	62%
Mean monthly electricity cost excluding taxes and miscellaneous charges	$ 119.69	$ 44.24	63%
Total kWh cost, 12 months	$1,434.87	$ 529.13	63%
Total electricity bill, 12 months	$1,562.89	$ 591.48	62%
Gas Costs			
Mean annual gas cost including taxes and miscellaneous charges	$ 516.61	$ 369.21	29%
Mean annual gas cost excluding taxes and miscellaneous charges	$ 485.05	$ 346.30	29%
Mean monthly gas cost including taxes and miscellaneous charges	$ 43.22	$ 30.91	29%
Mean monthly gas cost excluding taxes and miscellaneous charges	$ 40.58	$ 28.99	29%
Total therm cost, 12 months	$ 485.05	$ 346.30	29%
Total gas bill, 12 months	$ 516.61	$ 369.21	29%
Combined Utility Costs			
Total combined utility bill, 12 months	$2,079.50	$ 960.69	54%

Concluding Remarks

These findings have implications for policy makers. In addition to homebuilders, policy makers are taking notice of the investment and business potential of solar PV homes. Hering (2005) reports that the Million Solar Roofs initiative sets the goal of one million solar roofs by 2017. Senate Bill 1 set the goal of installing PV on half of all new homes by 2017 and on 10% to 20% of all new homes by 2010. The recently authorized California Solar Incentive (CSI) program has similar goals, setting more than $3 billion aside over 10 years for construction of highly efficient solar homes.

References

Coburn, Timothy C., Barbara C. Farhar, and Megan Murphy. 2004. "Comparative Analysis of Homebuyer Response to New Zero Energy Homes." In *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, 8.48−8.60. Washington, D.C.: American Council for an Energy-Efficient Economy.

Collins, Nancy. 2003. "Zero Energy-Use Homes Project: Interviews with People Who Visited the SheaHomes Scripps Highlands New Home Development." White Paper funded by the National Renewable Energy Laboratory. Oakland, Calif.: Q^4 Associates.

Farhar, Barbara C., and Timothy C. Coburn. 2006 (Forthcoming). *A Comparative Market and Utility Analysis of New High-Performance Homes in San Diego*. Technical Report no. TP-550-38304. Golden, Colo.: National Renewable Energy Laboratory.

Farhar, Barbara C., Timothy C. Coburn, and Nancy Collins. 2002. "Market Response to New Zero Energy Homes in San Diego, California." In *Proceedings of the 2002 ACEEE Summer Study on Energy Efficiency in Buildings*, 8.41−8.54. Washington, D.C.: American Council for an Energy-Efficiency Economy.

Farhar, Barbara C., Timothy C. Coburn, and Megan Murphy. 2004. "Large-Production Home Builder Experience with Zero Energy Homes." In *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings*, 8.98−8.109. www.nrel.gov/docs/fy04osti/35913.pdf. Washington, D.C.: American Council for an Energy-Efficiency Economy.

Hammon, Rob. 2005. "The Near-Zero-Energy House." *Solar Today*, 19: 22-25.

Hering, Garrett. 2005. "Solarizing the American Dream." *PHOTON International*, 80−85.

Keesee, Michael. 2005. "Setting A New Standard: Zero Energy Homes in the U.S." *reFOCUS*, July/August: 26−28.

Keesee, Michael, and Rob Hammon. 2006. "Sacramento's Zero-Energy Home Community." *Home Energy*, March/April: 24−31.

Murr, Andrew. 2005. "No More Electric Bills." *Newsweek*, August 15: 43.

[RESNET] Residential Energy Services Network. 2006. "Adopted 2005 Enhancements of the National Home Energy Rating Standards." www.natrestnet.org/amendments/default.htm. Accessed May 4.